JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 23 SEPTEMBER 15, 1933 No. 9

PHYSICS.—*The seismic receiver.*[1] F. W. SOHON, S. J., Georgetown University. (Communicated by F. G. BRICKWEDDE.)

The radio receiver has grown familiar to us as a household article and while it is really more complicated than the seismograph, a comparison of the two may serve to dispel some of the mystery associated with the receiver of seismic manifestations. Both are harbingers of distant tidings, one indulging in phonetics and the other speaking in idiograms; and while at first sight one might hesitate about pursuing the analogy too closely, knowing that all comparisons limp, still on further reflection one easily appreciates that the resemblance is far from superficial.

The first thought that strikes us is that both the seismic receiver and the radio receiver are devices actuated by wave motions. The radio receiver responds to waves set up in the ether, or if there is no ether, it responds to the equivalent of what we have been calling waves in the ether that are set up by a transmitting station. The seismic receiver takes cognizance of waves set up in the interior of the earth and on its surface by the earthquake shock itself which does its own transmitting. There are differences, of course, and we might mention the fact that the ether waves are transverse, while the earth transmits both longitudinal and transverse waves, both pushing and shaking phenomena. We shall not stop to point out analogies between the two kinds of wave motion, but merely mention the fact that the path of the seismic message is worked out by geometrical optics, that we have reflection and refraction and dispersion of seismic waves in the interior of the earth, and that if the seismic problem is complicated by surfaces of discontinuity beneath the surface of the earth, the radio problem is not made any simpler by the Heaviside layer above the earth's surface. But let us put all this aside as more or less obvious now that it has been called to our attention, for we are more interested in the instruments themselves.

[1] Paper delivered before the Philosophical Society of Washington, February 11, 1933. Received February 16, 1933.

Apart from rectifying and amplifying devices and other accessories, the heart of the radio receiver is its oscillating system, and when we understand the oscillating system we stand a fair chance to understand something about the radio receiver. The oscillating device consists of three essential elements, an inductance, a capacity, and resistance, or as we might say, a sustaining element, a storing element, and a smothering element. When we have an axcess of electrons on one plate of the condenser and a deficiency on the other, the situation is relieved by a flow of electrons through the circuit. The office of the inductance is to sustain the flow, and on account of this action, the flow does not stop when things are just balanced, but continues until the sustaining power of the inductance is overcome by the back pressure due to the excess of electrons on the other side of the condenser. Then the process reverses. A seismograph is a kind of pendulum in most cases, and instead of an inductance the sustaining element is the inertia of the swinging system. The storing element which takes the place of the condenser consists in the rise of the weight against the force of gravity, in most cases, or it may consist in the stretching of a spring or the twisting of a wire. When the moving system has been displaced from the equilibrium point, then gravity, or the recoil of a spring, or the torque of a wire pulls the system back. But just as the motion of the electrons was sustained by the action of the inductance, so the motion of the seismograph is sustained by the inertia of the moving parts. The weight is thus rushed past the point of equilibrium until the momentum is overcome and the motion arrested by the operation of the restoring forces on the other side. In the radio receiver, an oscillation once set up would never cease were it not for the resistance of the circuit that dissipates the energy in the form of heat. The seismograph would never come to rest were it not for the smothering effect of friction or damping devices that more or less quickly destroy the motion of the boom.

But the analogy between the radio receiver and the seismic receiver does not stop with these fundamental structural details, but extends itself to functional considerations. Every oscillating system has a natural frequency determined by the relation between the sustaining, the storing, and the smothering elements. When you turn the dial of your radio receiver, by adjusting the relation between inductance and capacity, you change the frequency of the circuit. As you approach the proper adjustment for a station, the output is at first faint, but swells up rapidly to a maximum, and then as you continue to turn, it becomes faint again. With the seismograph we do

not stay at hand to tune it all the time, so the same effect is produced as the period of the seismograph remains fixed and that of the incoming wave varies, mostly out of tune. The magnification of a seismograph varies in exactly the same way that the amplification of a radio set varies when it is not exactly in tune, and the greater the discrepancy between the wave length of the instrument and the length of the incoming wave, the smaller the magnification. That is why it is necessary for a correct interpretation of a seismogram, to measure the period of each wave, find the magnification corresponding to its wave length from tables or curves and then to correct the trace amplitude for the variable magnification. For the same reason the question of the choice of a proper period for a seismograph is a long story, which can not be told here.

This variable magnification which gives so much trouble in a seismograph is a great virtue in the tuned stages of a radio set and every effort is made to encourage it. Hence the reduction in the size of the antenna, the use of the indoor antenna, loose couplings. The idea is to get as narrow a band of frequencies as possible. With the seismograph we try to get as tight a coupling as possible, a concrete pier going down to bed rock, making the frame of the machine as nearly as possible a part of the earth itself. Broadening the band of frequencies to which an oscillating system is sensitive or in other words decreasing the selectivity is possible if we increase the smothering action, increase the resistance of the radio circuit, increase the damping of the seismograph. The effect of this procedure is twofold. The band of frequencies through which a response is obtained is broadened. This represents a loss in selectivity, but a gain for sensitivity except for waves that happen to be in tune. At the same time a general flattening of the magnification curve takes place, reducing the magnification. The flattening of the magnification curve is a great advantage to the seismologist as we shall see presently, though the loss in magnification is a disadvantage. In the earlier instruments before the introduction of optical recording this was a heavy sacrifice. Hence the damping was kept very low. Even then, to overcome the friction of the needle point plowing its way through a film of soot on a highly glossed paper, the mass of the instrument had to be made very great if much magnification was desired. Now with the perfected methods of optical registration, we can afford to push the damping up until the system just ceases to oscillate.

In the radio set on the other hand it is selectivity and not sensitivity that is desired. Low resistance wire is used. Braided wire is

used. Connections are made as short as possible and are kept tight by soldering. It is all to make the set as selective as possible, to make it sensitive to as narrow a band as possible. Of course one can go too far even in a radio set, and spoil the modulation by shaving the band too close. But it will be understood that we are here merely speaking of tendencies.

In spite of all efforts to the contrary a certain amount of selectivity is obtained in a seismograph. The slow speed of the paper, which is as low as 6 mm. per minute on some instruments, and is as high as 60 on others, means that vibrations that are too quick will be lost due to the thickness of the trace or to the overlapping of images where optical recording is employed. You have something similar to this in the limited sensitiveness of the diaphragm of your ear phone or the armature of your loud speaker. According to Galitzin, selectivity of this kind is more or less of a virtue, because the quick vibrations that would be recorded would for the most part be those due to machinery and would be evidence of industrial rather than seismic activity. Since his time, however, we have begun to realize that while the long periods characterize the waves from the distant sources that have come through the heavier, deeper rocks, the near-by earthquakes send their messages in quicker vibrations through the lighter rocks near the surface. Hence to record close earthquakes one must be ready to make something of shorter periods than Galitzin was interested in. Again if we are interested in accelerations instead of displacements the shorter period instrument gives a better picture. But no radio set records when it is so far out of tune, so we pass these questions and many others with the acknowledgment that things are not quite as simple as we are trying to make them out to be.

Our modern radio sets secure an increase in magnification by connecting the first oscillating system to another through a transformer. In these sets there is more than one circuit to be tuned but we have an increase in amplification with an increase in selectivity. Galitzin, to secure the same end does a similar thing, though he does not regard the increased selectivity as an advantage. Instead of securing additional magnification through a system of levers, Galitzin has placed a set of coils on the end of the boom in a magnetic field maintained by permanent magnets attached to the frame of the seismograph. If the boom of the seismograph moves, an electromotive force is produced in the coils, and this serves to operate a sensitive galvanometer. The record is made optically by reflecting a beam of light from the mirror of the galvanometer to a drum with sensitive bromide paper. In the

transformer of the radio set we have two electric circuits linked together by a magnetic circuit. In the Galitzin arrangement we find that we have two magnetic circuits, one at the pendulum, one in the galvanometer, linked together by a single electric circuit. So we see that the Galitzin scheme for obtaining an increased response for a given input signal is not so different from the radio scheme after all. A precisely similar statement holds for the Wenner instrument.

The resemblance between a seismograph and a radio set extends even to the defects. The howling and squawking of a radio set is the distortion produced by the internal oscillation of the set. It is precisely the distortion produced by the proper motion of the seismograph that creates the great problem for the makers of those instruments. One source of the distortion is the fact that the magnification curve is not flat. There are other sources, and these have also their electrical analogies. And just as radio manufacturers quite justly insist that purity of tone is the greatest factor in deciding between instruments or another, so in seismographs the question of the purity of the record is of importance, and there has been much said on the point by designers of different types of seismographs, even though we have had to sacrifice our ideals in this regard in order to get a practical working instrument.

GEOLOGY.—*Bentonite in northern Virginia.*[1] R. R. ROSENKRANS, Pennsylvania State College. (Communicated by JOHN B. REESIDE, JR.)

It is now a little more than a decade since bentonite of middle Ordovician age was first reported from strata of the Appalachian province. Many additional occurrences have been discovered in recent years and the attention of the stratigrapher has been focused upon the possibilities of using these bentonite beds as key horizons in close stratigraphic correlation.

The idea is not new, though as yet extensive application of the correlation of bentonite beds to the solution of stratigraphic problems, except in one or two places, has not been made. The value of a bentonite bed for such work lies, of course, in the fact that it represents an ash fall which occurred within a very brief interval of time. Where such a bentonite bed is interstratified with unquestionable marine strata, the immediately subjacent strata must be essentially contem-

[1] Received April 23, 1933.

poraneous. If a single bentonite bed, or better still a series of them, can be recognized in a series of sections, the contemporaneity of these sections is practically established.

Within the past year and a half through the work of the writer[2] and through the work of Whitcomb[3] it has been established that a series of six thin bentonite beds occur in the basal portion of the Salona formation (late Black River or early Trenton age) of central Pennsylvania. These beds have been carefully traced throughout the

TABLE 1.—GENERALIZED SECTION OF THE BASAL SALONA OF CENTRAL PENNSYLVANIA

| | Feet | Inches |
|---|---|---|
| Salona formation: | | |
| Shales, black, calcareous, slaty, interbedded with impure, shaly, dense, black limestones | | |
| Bentonite (No. 5) | 0 | 6 |
| Shales, black, calcareous, slaty and impure limestones carrying *Homalonotus trentonensis* in upper portion | 65 | |
| Bentonite (No. 4) | 0 | 3 |
| Limestones, shaly, impure, thin-bedded | 35 | |
| Bentonite (No. 3) | 0 | 8 |
| Limestones, shaly, impure, thin-bedded | 15 | |
| Bentonite (No. 2) | 0 | 6 |
| Limestone, black, impure, with upper two inches silicified (very cherty) and with upper surface characteristically checked, yellowed, and covered with fossil fragments, frequently *Cryptolithus* | 1 | 3 |
| Bentonite (No. 1) | 0 | 1 |
| Limestone, thin-bedded, shaly, black | 15 | |
| Bentonite (No. 0) | 0 | 1 |
| Limestone, dense, black, non-fossiliferous | 0 | 9 |
| Rodman formation: | | |
| Limestone, cobbly, impure, coarsely crystalline, crinoidal | 2 | |
| Limestone, crinoidal, gray, coarsely crystalline | | |

entire middle Ordovician province of central Pennsylvania. As a result of this detailed work much light has been shed on certain stratigraphic problems of the area. One of the questions, however, that has been of much concern to the student of Appalachian stratigraphy has been that of the exact relationship of the central Pennsylvania middle Ordovician formations to those of neighboring areas.

Having successfully traced a series of bentonite beds throughout the Pennsylvania area the writer directed his attention to the possibility of recognizing these beds in adjacent areas. As it has long been postulated that the source of the middle Ordovician volcanic ash was in the southeastern portion of the United States, possibly in central

[2] ROSENKRANS, R. R. Master's Thesis, (unpublished), Pennsylvania State College, 1933.

[3] WHITCOMB, L. *Correlation by Ordovician bentonite.* Journ. Geol. 15: 522–534. 1932.

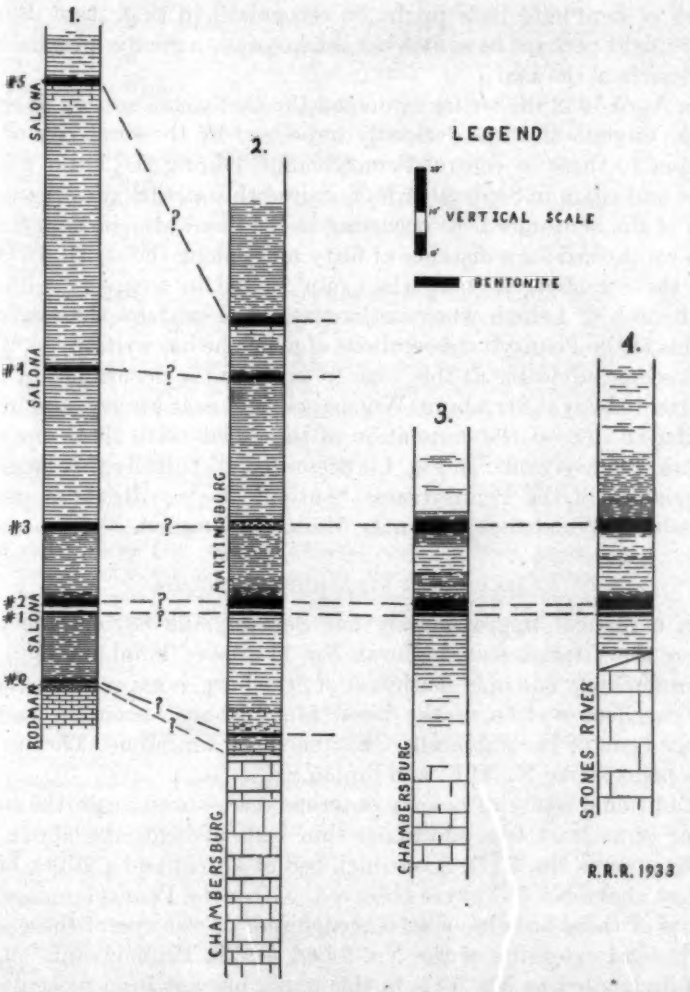



Fig. 1.—Correlation of the basal Martinsburg bentonites in northern Virginia and the suggested correlation of these beds with the bentonites at the base of the Salona formation in central Pennsylvania. 1. Generalized columnar section of the basal Salona of central Pennsylvania. 2. Section as exposed along highway No. 11 approximately one mile southwest of Strasburg, Virginia. 3. Section at Woodstock, Virginia. 4. Section near Maury, Virginia. Note that the thickness of the bentonite beds is greatly exaggerated. Note the persistence of the group of beds consisting of bentonites No. 1, No. 2, and the intervening strata. This group was persistent throughout the entire central Pennsylvania Middle Ordovician province.

or southern Virginia,[4] it seemed quite likely that the above-noted series of bentonite beds might be recognized in that state, though they might perhaps be somewhat thicker due to greater proximity to the source of the ash.

In April 1932 the writer examined the Ordivician section at Strasburg, Virginia and was decidedly impressed by the similarity of this section to those in central Pennsylvania. During the latter part of June and again in September he revisited this section and traced certain of the bentonite beds occurring in the basal Martinsburg formation southward for a distance of forty miles along the strike. In October the Strasburg section was again visited in company with Dr. Whitcomb of Lehigh who was likewise impressed by the similarity of this to the Pennsylvania sections of which he has written.[5]

It seems advisable at this time to describe the occurrence of these bentonite beds at Strasburg, Woodstock, and near Mauzy, and in particular to suggest the correlation of these beds with those traced in central Pennsylvania. In Fig. 1 is presented graphically this suggested correlation of the Pennsylvania bentonite beds with those seen at Strasburg, Woodstock, and near Mauzy in Virginia.

## SECTION AT STRASBURG, VIRGINIA

In a roadcut approximately one quarter mile beyond the point where the Virginia state highway No. 11 crosses Tumbling Run, and approximately one mile southwest of Strasburg, is exposed the following excellent section of the basal Martinsburg formation and the upper beds of the subjacent Chambersburg limestone. The beds at this point strike N. 30 E. and dip 35 SE.

Additional study of nearby outcrops seems to indicate the occurrence of at least two additional thin beds of bentonite above that designated as No. 5 (?). A one-inch bed at 37 feet and a 2-inch bed at 61 feet above No. 5 (?) were observed. No central Pennsylvania equivalents of these beds have been recognized, or else one of these is the southward extension of the No. 5 bed seen in Pennsylvania and the bed designated as No. 5 (?) in this paper has not been recognized in the northern sections.

Along the road leading from the main highway to Fisher's Hill, and along the banks of Tumbling Run there is exposed a complete section of the Chambersburg limestone. At least four beds of bentonite occur

[4] GILES, A. W. Journ. Geol. 35: 527–541. 1927. Gives summary of statements by W. A. Nelson as to location of vent supplying the middle Ordovician volcanic ash.
[5] WHITCOMB, L. Op. cit., pp. 522–534.

TABLE 2—SECTION OF BASAL PART OF MARTINSBURG FORMATION AND UPPER PART OF CHAMBERSBURG LIMESTONE

| | Feet | Inches |
|---|---|---|
| Martinsburg formation: | | |
| Shale, slaty, calcareous, brown to black | | |
| Covered interval | 50 | |
| Shale, calcareous, slaty, weathers brown | 28 | |
| Bentonite (No. 5?) | 0 | 6 |
| Shale, calcareous, slaty, less calcareous at base and containing abundant graptolites (*Diplograptus* sp.) at 3 feet | 9 | |
| Shale, very blocky | 1 | |
| Bentonite (No. 4?) | 0 | 3 |
| Limestone, light gray, coarse, very fossiliferous, seems to be composed entirely of the remains of a small brachiopod | 0 | 3 |
| Shale | 32 | |
| Bentonite and shale, zone consisting of a 1-inch bentonite bed resting on an 8 inch bed of bentonitic shale from which it is separated by a thin layer of slickensided calcite, and this bed in turn resting on a thin layer of bentonite (No. 3?) | 0 | 10 |
| Shale, earthy, brown-weathering, abundant remains of *Cryptolithus* and some large *Lingula* at 8 feet | 14 | |
| Shale, black, blocky | 1 | |
| Bentonite, massive (No. 2?) | 0 | 10 |
| Shale, massive bed, very fossiliferous, upper portion silicified (cherty) and with the upper surface characteristically checked, yellowed, and with numerous fossil fragments including *Cryptolithus*. At 6 inches this bed seems to be composed entirely of the remains of a large *Asaphid* | 0 | 9 |
| Shale, thin, chocolate colored | 0 | 2 |
| Bentonite (No. 1?) | 0 | 3 |
| Shale, calcareous, light gray on weathered surface, earthy, very fossiliferous, with *Christiania* abundant and occasional *Echinosphaerites* | 22 | |
| Shale, thin, brown, weathers to brown mud | 0 | 3 |
| Shale, calcareous, cobbly, with at least three zones of large nodular limestone concretions | 5 | |
| Bentonite (No. 0?) | 0 | 2 |
| Shale, calcareous, very cobbly, bluish-gray | 2 | 4 |
| Chambersburg limestone: | | |
| Limestone, massive, dense, thin-weathering, bluish | 1 | 3 |
| Limestone, bluish and cobbly | 0 | 5.5 |
| Shale, gray, thin | 0 | 4 |
| Limestone, massive, bluish | 1 | 3 |
| Bentonite or bentonitic shale, a thin bed largely shale | 0 | 1 |
| Limestone, massive, bluish, very few fossils | 6 | 2 |
| Bentonite or bentonitic shale | 0 | 1 |
| Limestone, massive, bluish | 18 | 9 |
| Shale, yellowish and possibly somewhat bentonitic | 0 | 2 |
| Limestone, massive, bluish-gray, with *Nidulites* scarce in upper beds but becoming more abundant in lower beds | | |

near, or a little below, the base of this limestone. One of these is 9 inches thick, and one is 6 inches thick. Each of the other two is only one inch thick. Whether these have any central Pennsylvania equivalents or not is at present unknown, though several thin bentonite beds occur in the Carlim of that area.

Along the bed of a small creek at the east edge of Woodstock is exposed a partial section of the basal Martinsburg and the upper beds of the subjacent Chambersburg. At this locality the beds No. 1 (?), No. 2 (?), and No. 3 (?) are exposed. Bed No. 0 (?) is probably present though this portion of the section is covered. A few feet below this horizon the thick bluish limestone beds of the upper Chambersburg are exposed.

At a point seven miles south and a quarter mile east of New Market a partial section of the basal Martinsburg is exposed. Bentonite beds No. 1 (?), No. 2 (?), and No. 3 (?) are exposed here. Nine feet beneath No. 1 (?) the basal Martinsburg has been faulted against massive, dove-colored strata of Stones River age, the intervening Chambersburg beds having been cut out.

In each of the three above mentioned sections occur the group of beds consisting of the thick bentonite No. 2 (?), the thinner bentonite No. 1 (?), and the intervening 12–20 inches of shale, the upper portion of which has been silicified. The surface immediately beneath bentonite bed No. 2 (?) is characteristically checked, yellowed, and covered with fragmentary fossils among which are fragments of *Cryptolithus*. This group of beds is apparently the same as that which served as a readily recognizable datum in tracing the bentonites of central Pennsylvania. If it is not the same group, then this is a most remarkable coincidence. The approximate equivalence in age of the containing strata as established on paleontological grounds, the lithologic similarity of these strata, and the additional occurrence of bentonite beds No. 0 (?), No. 3 (?), No. 4 (?), and No. 5 (?) strengthen the suggested correlation of these sections with the basal Salona formation of central Pennsylvania.

In this paper which contains only a brief statement of the occurrence and correlation of the bentonite beds in the basal Martinsburg of northern Virginia, and a suggested correlation with the beds of central Pennsylvania, it is not necessary to discuss the petrography of these bentonites. However, the writer has studied material from each of the outcrops cited, and has established by petrographic methods that it is bentonite.

This correlation of the basal Salona of Pennsylvania with the basal

Martinsburg of northern Virginia, if substantiated by further detailed work which has been undertaken by the writer, will prove a distinct step toward clarifying the relations of the middle Ordovician of central Pennsylvania to the neighboring Ordovician terranes.[6]

[6] The writer is indebted to Dr. Lawrence Whitcomb of Lehigh University, to Dr Josiah Bridge of the U. S. Geological Survey, and to Dr. E. O. Ulrich who have kindly read the manuscript of this paper and have offered many helpful suggestions.

BIOCHEMISTRY.—*The evaluation of the Rupp-Schied-Thiel method as a test for thiocyanate in the urine.*[1] M. X. SULLIVAN and W. C. HESS, Georgetown University.

The iodometric method for thiocyanate devised by Rupp and Schied (1) and improved by Thiel (2) has been used considerably in biochemical work. Gies and collaborators (3), (4) found it satisfactory in their extensive study of thiocyanate in the mammalian body. Saxl (5) applied it to the urine in cancer and concluded that quantitatively thiocyanate is increased in the urine in cancer with values appreciably higher than normal and higher than found in any other disease. Sullivan and Dawson (6) made use of the method in their study of pellagra. In the pellagra work comparative values between the acute and cured conditions were sought and no attempt was made to determine the degree of specificity of the Rupp-Schied-Thiel reaction for thiocyanate when applied to saliva or urine. Recently, Sullivan and Hess (7) used the method in a study of the urine of various pathological conditions, cancer in particular. In their work a number of cases of marked cancer involvement showed high apparent thiocyanate as found by Saxl but other cases of cancer marked enough to lead to death were within normal limits and sometimes below normal. They concluded that the excretion of material behaving like thiocyanate is not necessarily increased in cancer.

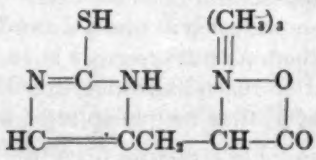
Sullivan and Hess found exceedingly high thiocyanate values in multiple myeloma (malignancy of the bone marrow) and were led to the conclusion that other substances than thiocyanate were possibly being measured. From theoretical grounds, also, it seemed that the specificity of the Rupp-Schied-Thiel procedure might be questionable when applied to a complex such as urine. Accordingly, a critical study was made of the method. As will presently be shown, other substances in urine were found to react like thiocyanate in the Rupp-Schied-Thiel procedure, that is, they are precipitated by silver nitrate in the

[1] This work was supported by a Research Grant from the Chemical Foundation. Received June 9, 1933.

presence of dilute nitric acid and the precipitate reacts with iodine under the same condition that thiocyanate does in a medium made alkaline with sodium bicarbonate and containing potassium iodide. The details of the Rupp-Schied-Thiel procedure as applied to urine are given by Saxl (5) and with slight modification by Sullivan and Dawson (6) and Sullivan and Hess (7).

In testing the degree of specificity of the Rupp-Schied-Thiel reaction, tests were made on urinary pigment, creatine and creatinine, taurine, glyoxal, glutathione, uric acid, xanthine, guanine, and adenine, ergothioneine, urinary proteose, and oxyproteic acids. A normal urine freed to a high degree from pigment by Drabkin's (8) method gave 88 per cent as much thiocyanate-like material as before the extraction. Creatine and creatinine and taurine give no precipitate with silver nitrate in acid solutions and do not react with iodine in an alkaline medium. Glyoxal does precipitate with silver nitrate and takes up iodine; so if present (for the probability of which we offer no proof), it would interfere in the thiocyanate work. Neither oxidized nor reduced glutathione gives a precipitate with silver nitrate though they will use up iodine. Xanthine, guanine, and adenine are precipitated by silver nitrate but do not react with iodine in an alkaline medium in the procedure followed. Uric acid reacts with iodine in alkaline medium somewhat like thiocyanate, 10 mg. of uric acid are in fact equivalent to 4.47 mg. of KCNS. While uric acid in aqueous solution as the sodium salt is not readily precipitated by silver nitrate, sodium urate added to urine is in part precipitated by silver nitrate and is to some slight degree a positive interferer in the Rupp-Schied-Thiel reaction. The greatest interference apparently comes from other sources such as ergothioneine-like compounds and oxyproteic acids which are considered below.

*Ergothioneine.*—This compound isolated from blood by Benedict (9), Benedict, Newton, and Behre (10), Hunter and Eagles (11), (12), was found by Newton, Benedict, and Dakin (13) to be identical with the base ergothioneine isolated from ergot by Tanret (14), and shown by Barger and Ewins (15) to be the betaine of thiohistidine:



Having on hand a sample of ergothioneine isolated from blood, it was tested to see if it would react like thiocyanate in the Rupp-Schied-Thiel procedure. Five milligrams were dissolved in 25 cc. of water. This solution gave a gelatinous precipitate with silver nitrate. The precipitate was centrifuged, washed, and put through the thiocyanate procedure. It was found that 5 mg. of ergothioneine ($C_9H_{15}N_3SO_2 \cdot 2H_2O$) was the equivalent of 2.9 mg. of KCNS, or 1.763 mg. of HCNS.

Benedict, Newton, and Behre (10) showed that ergothioneine is precipitated by silver lactate in the presence of lactic acid as uric acid is but unlike uric acid is not freed from the silver compound by treatment with acid sodium chloride used in the Folin-Wu (16) method for uric acid. In their procedure the silver insoluble complex freed from uric acid and dissolved in sodium cyanide gives a blue color with the uric acid reagent and sodium hydroxide.

The Benedict (17) blood procedure was then applied to the urine. To 3 cc. of urine, Folin-Wu's acid silver lactate was added in slight excess. The mixture was centrifuged and the supernatant liquid decanted. The insoluble residue was washed by stirring with acid sodium chloride (10 per cent sodium chloride in 0.1 N hydrochloric acid) in 50 cc. lots, centrifuging and decanting until the washings no longer gave a color with the uric acid reagent.

The insoluble residue was put into solution with the minimum amount of 5 per cent sodium cyanide. To do this 6 cc. of the cyanide was usually required so the use of 6 cc. of cyanide was made a routine. To the solution in cyanide were added 1 cc. of the Folin-Marenzi (18) reagent and 1 cc. of N sodium hydroxide. The standard solution for comparison was 0.5 mg. of ergothioneine dissolved in 6 cc. of 5 per cent sodium cyanide and treated in the same manner as the unknown. As Behre and Benedict (17) in their study of blood give evidence of the presence of other material behaving like ergothioneine, the material judged to be present in urine is labeled ergothioneine-like. This ergothioneine-like material reacts like thiocyanate in the Rupp-Schied-Thiel method but is entirely distinct from thiocyanate. The latter is extracted to a large degree from the silver nitrate precipitate by acid sodium chloride and, more important still, does not react with the uric acid reagent as ergothioneine does.

In normal urine the amount of material reacting like ergothioneine excreted in 24 hours varied from 76 mg. to 154 mg. as judged by colorimetric comparison with the standard ergothioneine from blood. The average of 11 normals was 117 mg. for an average volume of 1311 cc.

or approximately 89.2 mg. per liter. In the Rupp-Schied-Thiel thiocyanate procedure this amount of ergothioneine-like material considered as ergothioneine would be the equivalent of 31.46 mg. of HCNS as 5 mg. of blood ergothioneine was found by us to be equivalent to 1.763 mg. of HCNS. The presence in the urine of substances comparable to ergothioneine makes work with the Rupp-Schied-Thiel method a questionable measure of thiocyanate. Attention was then given to the study of ergothioneine in urine. The details of the ergothioneine investigation, which by isolation methods prove the presence of at least some ergothioneine in urine, will be given in a subsequent paper.

*Urinary proteose.*—Oriel and Barber (19) isolated from urine material which they called urinary proteose. This they found the carrier of antigenic properties in allergic conditions. It occurs in normal urine but generally in much smaller amounts than in pathological urines and not accompanied by antigenic material.

In testing Oriel and Barber's claims, the so-called proteose was collected from a number of urines, normal and from allergic conditions. When put through the Rupp-Schied-Thiel procedure, (precipitation with silver nitrate and reaction with iodine etc.), 100 mg. of the combined crude proteose in 15 cc. of water and 2 cc. of 1 per cent nitric acid were found to have a thiocyanic acid equivalent of 2.736 mg. From normal urines with a single individual using the Oriel and Barber treatment there have been isolated on the average 400 mg. of crude proteose per liter. Accordingly, the proteose is more or less a positive interferer in the Rupp-Schied-Thiel thiocyanate method.

*Oxyproteic acid.*—Oxyproteic acids were isolated as barium salts following Pregl's (20) procedure. This complex is precipitated by silver nitrate and reacts with iodine as thiocyanate does. From normal urine, Pregl isolated more than 5 grams of the barium salt of oxyproteic acids per liter of urine. In the present work there was obtained 6.43 grams of the barium salt of oxyproteic acids per liter of urine or 122.2 grams from 19 liters. One hundred milligrams of this salt containing 28.61 per cent barium was equivalent in the Rupp-Schied-Thiel procedure to 1.2 mg. of KCNS so 5 grams would be equivalent to 60 mg. of KCNS or 36.5 mg. of HCNS.

When tested by the Benedict procedure for ergothioneine and by the Hunter (21) ergothioneine reaction both the proteose and the barium salt of oxyproteic acid were found free of ergothioneine. Conversely, neither the proteose nor oxyproteic acid interfere in the estimation of ergothioneine-like material. Both these compounds are pre-

cipitated by silver lactate but are washed out by the acid sodium chloride mixture in the same way that uric acid is.

In tests on individual urines it was found then that the thiocyanic acid value of the proteose and the oxyproteic acids was variable and

TABLE 1

ANALYSIS OF NORMAL URINE FOR TOTAL THIOCYANATE-LIKE MATERIAL, ERGOTHIONEINE, PROTEOSE, AND OXYPROTEIC ACID.

| Subject | Vol. | Apparent HCNS | Ergothioneine-like material calculated as ergothioneine | Proteose | Barium oxyproteic acids |
|---|---|---|---|---|---|
| | cc. | mg. | mg. | mg. | mg. |
| 1 (H) | 530 | 101.27 | 131.65 | 556 | 5.421 |
| 2 (S) | 800 | 66.19 | 109.20 | 354 | 5.828 |
| 3 (I) | 830 | 116.10 | 83.17 | 404 | 8.358 |
| 4 (W) | 830 | 140.60 | 77.61 | 664 | 5.937 |

peculiar to each indivual. Accordingly, total apparent thiocyanate and the thiocyanate value of ergothioneine-like material, proteose, and barium oxyproteic acids were determined on 4 individual urines. The apparent thiocyanate was determined by the Rupp-Schied-Thiel procedure; the ergothioneine-like material by colorimetric comparison with blood ergothioneine in the Behre and Benedict procedure; then

TABLE 2

THE THIOCYANATE EQUIVALENT OF ERGOTHIONEINE-LIKE MATERIAL, PROTEOSE, AND BARIUM-OXYPROTEIC ACIDS IN THE RUPP-SCHIED-THIEL METHOD FOR THIOCYANATE.

| Subject | Apparent HCNS | HCNS equivalent of | | | HCNS by difference |
|---|---|---|---|---|---|
| | | Ergothioneine | Proteose | Ba oxyproteinates | |
| | mg. | mg. | mg. | mg. | mg. |
| 1 (H) | 101.27 | 46.43 | 9.31 | 21.27 | 24.26 |
| 2 (S) | 66.19 | 38.51 | 5.23 | 11.48 | 10.87 |
| 3 (I) | 116.10 | 29.33 | 4.77 | 42.82 | 39.18 |
| 4 (W) | 140.60 | 27.37 | 13.08 | 46.93 | 53.22 |

proteose and the barium oxyproteic acid fraction by weighing air dried. The data obtained are given in Tables 1 and 2.

Inasmuch as the procedures of extraction employed do not extract all the proteose and oxyproteic acid from the urine, it is evident that the real thiocyanate content of a normal urine is small. It is indeed, smaller than given by difference in Table 2 as no data were obtained on the positive interference of uric acid in the Rupp-Schied-Thiel

thiocyanate method. It is certain, however, that the unmodified Rupp-Schied-Thiel iodometric method is not a measure of thiocyanate in the urine. Without comment on its applicability to extracts of blood and other tissue, it may be said that preliminary experiments indicate that the main material of the saliva reacting in the Rupp-Schied-Thiel procedure is thiocyanate.

*The Munk method.*—A method that has been employed for the estimation of thiocyanate is the Munk (22) gravimetric method. In this method the thiocyanate is precipitated by silver nitrate in the presence of dilute nitric acid and the silver precipitate is melted with sodium carbonate and potassium nitrate to convert the sulfur of the thiocyanate to sulfate. From the sulfur precipitated by barium chloride the thiocyanate is calculated. This method is likewise questionable when applied to urine because the silver nitrate precipitates other sulfur complexes than thiocyanate, among them ergothioneine-like material, proteose, and oxyproteic acid.

There is need of a more specific method for the determination of sulfocyanate in urine. Based on the observation that strong alcohol does not dissolve uric acid, ergothioneine, proteose, or the barium salt of oxyproteic acid whereas barium thiocyanate is soluble, a somewhat improved procedure has been employed as follows: An aliquot of urine, generally 50 cc., is treated with a saturated aqueous solution of barium hydroxide as long as a precipitate forms. The mixture is filtered and washed. The filtrate is brought to dryness on the water bath and is extracted with warm absolute alcohol and filtered. The procedure of evaporating, extracting with alcohol, and filtering is repeated. Then the alcohol is driven off, the residue dissolved in 25 cc. of water and the Rupp-Schied-Thiel procedure applied to the solution. Such a procedure has given a return of 97.2 per cent for potassium thiocyanate added to the urine and shows in urine amounts of thiocyanate very much smaller than the original Rupp-Schied-Thiel procedure applied to urine directly.

Using this procedure the amounts of thiocyanic acid found in the four urines of Table 2 become in fact, H, 14.2 mg.; S, 5.3 mg.; I, 17.6 mg.; and W, 25.5 mg.—values much lower than by difference as given in Table 2 and overwhelmingly lower than found by the unmodified Rupp-Schied-Thiel method.

## SUMMARY

The Rupp-Schied-Thiel procedure applied directly to urine is not specific for thiocyanate in that it gives positive results with ergo-

thioneine-like material, with proteose, and with oxyproteic acid and to some degree with uric acid. A large amount of the apparent thiocyanate material in urines in both the Rupp-Schied-Thiel procedure and in the Munk gravimetric procedure is explainable by the presence in the urine of ergothioneine-like material and of oxyproteic acids. An improved procedure is given which excludes most if not all the interfering substances and shows in urine amounts of thiocyanate very much smaller than does the original Rupp-Schied-Thiel procedure applied to urine directly.

## LITERATURE CITED


1. Rupp, E. and Schied, A. *Über die Iodometrie des Rhodanwasserstoffe.* Ber. Chem. Ges. **35**: 2191. 1902.
2. Thiel, A. *Zur Iodometrie des Rhodanwasserstoffe.* Ber. Chem. Ges. **35**: 2766. 1902.
3. Gies, W. J. and Kahn, M. *An inquiry into the possible relation of sulfocyanate to dental caries.* Dental Cosmos. **55**: 40. 1913.
4. Gies, W. J., Lieb, C. C., and Kahn, M. *A further study of sulfocyanate in its possible relation to dental caries.* Dental Cosmos. **56**: 175. 1914.
5. Saxl, P. *Über die Störungen im Eiweissstoffwechsel Krebskranker (Zugleich ein Beitrag zur Kenntnis der Rhodanausscheidung).* Biochem. Zeit. **55**: 224. 1913.
6. Sullivan, M. X. and Dawson, P. R. *Sulfocyanate content of the saliva and urine in pellagra.* Journ. Biol. Chem. **45**: 473. 1921.
7. Sullivan, M. X. and Hess, W. C. *Studies in cancer: The application of the Rupp-Schied-Thiel thiocyanate reaction to the urine in cancer.* This Journal **23**: 378. 1933.
8. Drabkin, D. L. *The normal pigment of the urine.* III. *A new method for its extraction.* Journ. Biol. Chem. **88**: 433. 1930.
9. Benedict, S. R. *The determination of uric acid in the blood.* Journ. Biol. Chem. **64**: 215. 1925.
10. Benedict, S. R., Newton, E. B. and Behre, J. A. *A new sulphur-containing compound (Thiasine) in the blood.* Journ. Biol. Chem. **67**: 267. 1926.
11. Hunter, G. and Eagles, B. A. *The isolation from blood of a hitherto unknown substance and its bearing on present methods for the estimation of uric acid.* Journ. Biol. Chem. **65**: 623. 1925.
12. Hunter, G. and Eagles, B. A. *Non protein-sulfur compounds of blood. I, Sympecthothion.* Journ. Biol. Chem. **72**: 123. 1927.
13. Newton, E. B., Benedict, S. R. and Dakin, H. D. *Chemical constitution of thiasine.* Science **64**: 602. 1926.
14. Tanret, C. *Sur une base nouvelle retirée du seigle ergoté, l'ergothionéine.* Comp. Rend. **149**: 222. 1909.
15. Barger, G. and Ewins, A. J. *The constitution of ergothioneine; a betaine related to histidine.* Journ. Chem. Soc. (London) **99**: 2336. 1911.
16. Folin, O. and Wu, H. *A system of blood analysis.* Journ. Biol. Chem. **38**: 81. 1919.
17. Behre, J. A. and Benedict, S. R. *The occurrence and determination of thioneine (ergothioneine) in human blood.* Journ. Biol. Chem. **82**: 11. 1929.
18. Folin, O. and Marenzi, A. D. *An improved colorimetric method for the determination of cystine in proteins.* Journ. Biol. Chem. **83**: 103. 1929.
19. Oriel, G. H. and Barber, H. W. *A proteose in the urine, excreted in anaphylactic and allergic conditions.* Lancet. **2**: 231. 1930.
20. Pregl, F. *Ueber die Ursachen der hohen Werthe des C/N Quotienten des normalen menschlichen Harnes.* (Pflüger) Arch. Physiol. **75**: 87. 1899.
21. Hunter, G. *A new test for ergothioneine upon which is based a method for its estimation in simple solution and in blood filtrates.* Biochem. Journ. **22**: 4. 1928.
22. Munk, I. *Quantitative Bestimmung des Schwefelcyansauregehalts im Speichel.* Virchows Archiv. **69**: 350. 1877.

PALEONTOLOGY.—*Mylodont (Ground Sloth) dermal ossicles from Colombia, South America.*[1] R. LEE COLLINS, Johns Hopkins University. (Communicated by E. W. BERRY.)

This paper reviews briefly some of the literature on dermal ossicles in the mylodont group of ground-sloths and describes some dermal bones collected by Dr. Maurice Rollot[2] from an old lake deposit in the southern part of the Bogotá Plateau, Colombia, South America. The bones are ascribed provisionally to *Mylodon robustus* Owen var. *tarijensis* Ameghino.

The presence of dermal bones in the mylodont group of ground-sloths has been known for many years. They were recorded as early as 1841 by Lund,[3] but apparently Burmeister[4] was the first to figure them and give a definite description of their appearance and a discussion as to their probable position in the skin of *Mylodon*. Conclusive evidence concerning the nature and position of such dermal armor in one mylodont genus, was furnished by the remarkably well preserved remains of *Glossotherium* (=*Neomylodon* and *Grypotherium*) discovered in a large cave at Consuelo Cove, Ultima Esperanza Inlet in the Magellan Territory of southern Chile. Skeletal material, the horny claws, fragments of the skin, and dung of the animal were collected by Eberhard and others in 1895, Nordenskjöld in 1896 and by Moreno in 1897. The nature and unusual preservation of this material caused much comment and speculation in the scientific world. Illustrations of the material were presented by Lönnberg,[5] Moreno and Woodward[6] and Hauthal, Roth and Lehmann-Nitsche[7] in 1899 and by Woodward[8] in 1900.

[1] Received May 1, 1933.

[2] Letter of September 18, 1932 from Dr. Maurice A. Rollot, Bogotá, Colombia to Prof. E. W. Berry of The Johns Hopkins University. . . . "et j'ai le plaisir de vous remettre aujourd'hui une collection . . . trouvées au contact d'un corps de *Mylodon*, au cours d'exploration y d'excavations, dans la partie sud du Haut Plateau de Bogotá. Le terrain appartient á une de ces anciennes lagunes e'tagées et supérandines, actuellement partiellement déséchées á une altitude de pres de 2.900 mts. . . . des os du *Mylodon*, qui put être identifié seulement á cause des dents, en tout semblable á ceux décrits par Marcelin Boule, dans son ouvrage sur les mammiferes fossiles du Tarija, S. A."

[3] LUND, P. W. K. Dansk. Vidensk. Selsk. Afhandl. 8: footnote p. 85. 1841.

[4] BURMEISTER, H. Anales Museo Publico, Buenos Aires. 1: 173, *pl. 5, fig. 8.* 1864–1869.

[5] LÖNNBERG, E. *On some remains of* Neomylodon listai *Ameghino brought home by the Swedish expedition to Tierra del Fuego 1896.* Wissensch. Ergebn. Schwedish. Exped. Magellansländ, 1895–1897 unter Leitung von Dr. Otto Nordenskjöld. 2: 149–170, *pls. 12–14.* 1899.

[6] MORENO, F. P. and WOODWARD, A. S. *On a portion of mammalian skin named* Neomylodon listai, *from a cavern near Consuelo Cove, Last Hope Inlet, Patagonia. With a description of the specimen.* Proc. Zool. Soc. London, pp. 144–156, *pls. 13–15.* 1899.

[7] HAUTHAL, R., ROTH, S. and LEHMANN-NITSCHE, R. *El mammífero misterioso de la Patagonia,* Grypotherium domesticum. Revista Mus. de La Plata. 9: 409–474, *pls. 1–5.* 1899.

[8] WOODWARD, A. S. *On some remains of* Grypotherium (Neomylodon) listai *and*

This brief paper does not warrant further references or more than the following short statement of some of the facts derived from the study of the *Glossotherium* remains. The skin described by Moreno and Woodward in 1899, is covered with hair varying in length from 10 to 65 millimeters and the bones are all confined to the inner portion of the dermis and never extend to the outer part in which the hair is implanted. The ossicles are irregularly arranged and closely spaced. The largest measure 10 by 15 millimeters, but the majority are smaller than this and large and small bones are indiscriminately mixed. They are irregular in form, the inner face is quite generally convex or pyramidal, the outer face slightly convex or more or less flattened, and there is no trace of definite patterns or sculpturing on them. This fragment of skin apparently came from the neck and shoulder region of the animal. A second fragment of skin, 100 by 93 centimeters, or almost twice the size of the preceding, was described by Woodward in 1900. It is supposed to have come from the trunk of the animal and there is a tendency, in what appears to be the middle part of the flank, for the ossicles to be arranged in rows parallel with the ribs. As the ventral border of the flank is approached, the bones dwindle in size or are lacking. The long axis of the elongate elements is nearly always coincident with the direction of the rows. A portion of skin bearing small ossicles was assigned more or less provisionally to the leg of the creature by Lönnberg in 1899.

In an article on the discovery of Quaternary mammals at Rancho La Brea, California, Merriam[9] recorded the occurrence of dermal bones in association with the remains of *Mylodon* and later[10] figured a layer of ossicles that were found more or less in their normal position, in a sheet of asphaltum overlying a mylodont scapula. Further remarks on the Rancho La Brea ossicles were contributed by Sinclair[11] who gave additional figures. The excellent report on the Cenozoic gravigrade edentates of North America by Stock[12] contains a review of the articles published on the dermal bones from the asphalt deposits. These bones are ascribed definitely to *Mylodon harlani* Owen.

---

*associated mammals from a cavern near Consuelo Cove, Last Hope Inlet, Patagonia.* Proc. Zool. Soc. London, pp. 64–78, *pls. 5–9.* 1900.

[9] MERRIAM, J. C. *Recent discoveries of Quaternary mammals in southern California.* Science, n. s. **24**: 248–250. 1906.

[10] MERRIAM, J. C. *Death trap of the ages.* Sunset Magazine. **21**: 465–475. 1908.

[11] SINCLAIR, W. J. *Dermal bones of* Paramylodon *from the asphaltum deposits of Rancho La Brea, near Los Angeles, California.* Proc. Amer. Philos. Soc. **49**: 191–195. 1910.

[12] STOCK, C. *Cenozoic gravigrade edentates of western North America, with special reference to the Pleistocene Megalonychinae and Mylodontidae of Rancho La Brea.* Carnegie Inst. Washington, Pub. No. **331**: 120–121, *pl. 21.* 1925.

The dermal ossicles from Colombia were found, as noted in the excerpt from Mr. Rollot's letter, in association with poorly preserved remains of a *Mylodon*. The teeth found with the skeletal remains appear to be similar to those of *Mylodon robustus* Owen var. *tarijensis* Ameghino, as figured by Boule[13] in an account of the fossil mammals from Tarija, Bolivia. On page 219, Boule mentions dermal bones from this animal, but does not describe or figure them. The Colom-

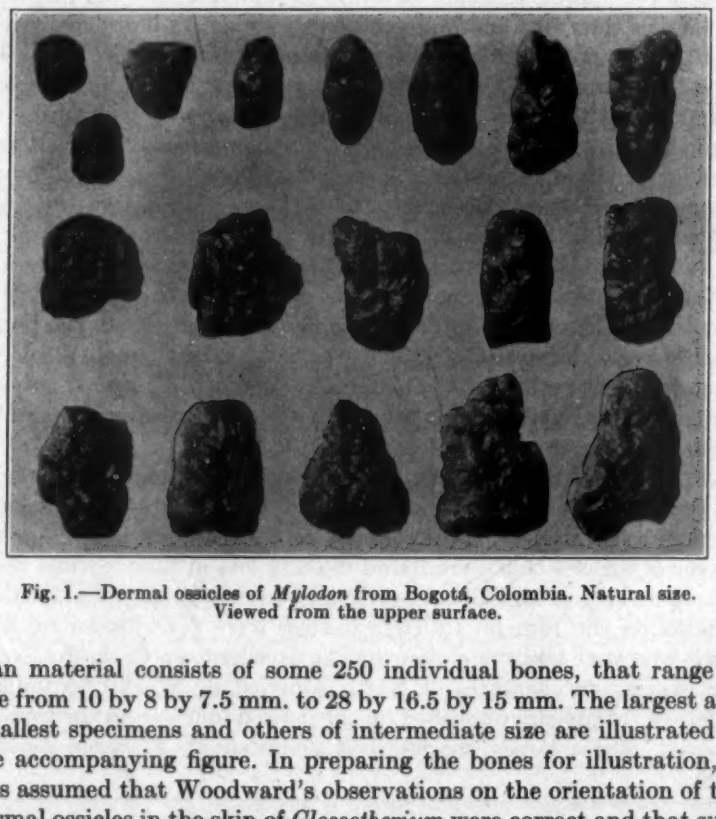


Fig. 1.—Dermal ossicles of *Mylodon* from Bogotá, Colombia. Natural size. Viewed from the upper surface.

bian material consists of some 250 individual bones, that range in size from 10 by 8 by 7.5 mm. to 28 by 16.5 by 15 mm. The largest and smallest specimens and others of intermediate size are illustrated in the accompanying figure. In preparing the bones for illustration, it was assumed that Woodward's observations on the orientation of the dermal ossicles in the skin of *Glossotherium* were correct and that supposedly the orientation, as suggested by Burmeister and others, was essentially similar in *Mylodon*. Therefore, the more highly pitted and less convex side, the so called, upper surface is represented in the

[13] BOULE, M. *Mammifères fossiles de Tarija*. With collaboration of A. THEVENIN. Mission scientifique G. de Crequi-Monfort et E. Senechal de la Grange. H. le Soudier (Paris), 1920.

figure. All of the specimens from Colombia are stained by oxides of iron and manganese on their exterior surfaces and also stained on the interior, but the discoloration here is confined largely to the regions adjacent to the vascular canals. The outer, more dense layer of bone is generally light brown in color, whereas the central, more porous part, is pale yellow or white with an occasional growth of black dendritic wad. In a few of the broken specimens the central bone material has largely disappeared and such individuals present much the appearance of geodes or concretions. There are no surface markings on the exterior other than irregular ridges and grooves and the pits formed by the entrance of the vascular canals.

Most of the Colombian ossicles are larger than those of *Glossotherium* and apparently more irregular in outline and surface markings. Some of them are distinctly elongate and in this characteristic they are somewhat similar to the elongate, oriented elements that Woodward describes from the fragment of skin ascribed to the flank of *Glossotherium*. Several of the smaller specimens approach somewhat the degree of regularity exhibited by the quadrilateral forms from *Mylodon harlani* as figured by Sinclair (Fig. 1, *b*, *c*, *d*) and Stock (Plate 21). The majority compare rather closely in size and irregularity with the more unsymmetrical individuals figured by Stock. They appear to be more like the ossicles described from *Mylodon* and are referred provisionally to *Mylodon robustus* Owen var. *tarijensis* Ameghino.

PALEONTOLOGY.—*A new Pennsylvanian trilobite from Missouri.*[1] JAMES S. WILLIAMS, U. S. Geological Survey. (Communicated by GEORGE H. GIRTY.)

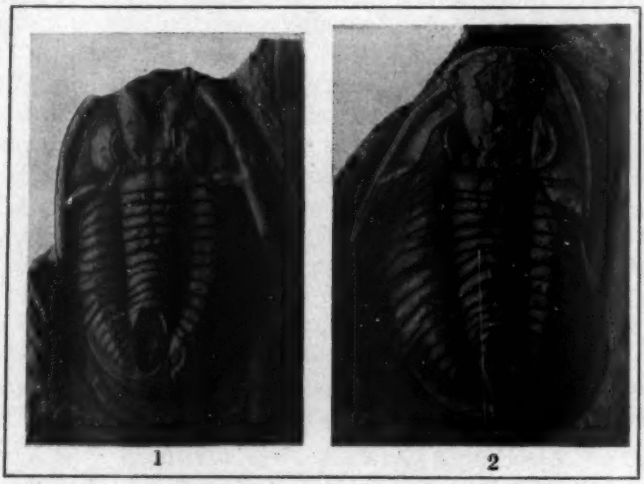
Complete dorsal shields of trilobites are rarely found in Pennsylvanian rocks, and their discovery is therefore always fortunate. If they represent new species, their description often prevents the creation of synonyms based on isolated parts. If they represent species previously known from incomplete specimens, the description may reveal the identity of two species or it may show that isolated pygidia and cephala placed in a single species are not truly conspecific.

The new species here described is based on two cotypes each of which has the cephalon, thorax, and pygidium in articulation. The typical specimens were collected by Mr. W. S. Olson and myself from the lower part of the Cherokee (lower Pennsylvanian) shale near Columbia, Missouri, in 1929, while studying the stratigraphy of the

[1] Published by permission of the Director of the U. S. Geological Survey. Received May 25, 1933.

Pennsylvanian rocks of the central Missouri fire-clay district. Although for many years trilobites have been known to occur in the Cherokee formation, this species is the first to be described from it from Missouri.

In describing this trilobite I have departed somewhat from the traditional practice and have given in advance of the detailed description and arranged under definite and mutually exclusive headings sufficient information for a working knowledge of the species. Although most paleontologists include this information in their de-




Figs. 1 and 2.—*Griffithides olsoni* Williams, n. sp. ×4. Fig. 1, cotype 5183; Fig. 2, cotype 5184.

scriptions, it is not always distinctly separated from the detailed description and is therefore sometimes difficult to find. If the specific characters were always summarized under definite headings, much unnecessary work by subsequent investigators would be avoided. The arrangement is by no means a new one. It has for a long time been in common use by some students of fossil vertebrates and some paleontologists have used it in describing genera and species of fossil invertebrates. It has not, however, been used to any extent by students of fossil invertebrates. A more extensive use of this arrangement would not only save time but would also be a step toward greater precision in fossil descriptions.

The photographs shown in the figures were made by N. W. Shupe and retouched by Miss Frances Wieser.

**Griffithides olsoni** Williams, n. sp.

*Specific diagnosis:* This species is characterized by the following combination of characters: small size, length less than twice the width, granulose surface, granules on glabella larger than those on rest of dorsal shield, most of granules on axial segments of thorax and pygidium irregularly arranged, small and inconspicuous basal lobes on glabella, no prominent mesial lobe between basal lobes, no transverse glabellar furrows except those that delimit basal lobes, nine segments in thorax, six complete pleural segments on pygidium.

*Comparisons:* In the number of segments on the pleural lobe of the pygidium, in its rather small size, and in several other characters, *G. olsoni* resembles *G. ornatus* Vodges, 1895, from the Pennsylvanian of Arkansas, *G. parvulus* Girty, 1911, from the Wewoka and Boggy formations of Oklahoma, and *G. scitulus* Meek and Worthen, 1865, a widespread Pennsylvanian species. Its closest resemblance is perhaps to *G. scitulus* and if the type of that species were available for study, my specimen might be found to be conspecific with it. I have, however, been unable to locate the type of *G. scitulus* and as a consequence must rely on the original and subsequent descriptions and on fragmentary and insecurely identified specimens in the United States Geological Survey collections from the type locality for data about it. Published figures do not show critical parts of the type in detail. Although *G. scitulus* has been described from several localities by different authors, it seems that Meek and Worthen were the only authors who examined the type.

*G. olsoni* differs from Meek and Worthen's original description of *G. scitulus* in the following ways: There are no indications of transverse glabellar furrows anterior to those that delimit the basal lobes on *G. olsoni; G. olsoni* has small basal lobes which, although the transverse furrows are not visible, appear to have raised portions that are more nearly suboval than subtriangular, and *G. scitulus* is said to have large subtriangular basal lobes; *G. olsoni* has no prominent mesial lobe between the basal lobes of the glabella. Another difference between *G. olsoni* and some forms described as *G. scitulus* is the absence of a single row of prominent nodes on each segment of the axis of the thorax and pygidium of *G. olsoni*. Although granules on some of the axial segments of *G. olsoni* appear to be so arranged, they are much smaller than the nodes attributed to *G. scitulus*. On some of the anterior segments of the thorax of *G. olsoni* granules are numerous but are not regularly arranged. They are only slightly smaller than the granules that appear to be regularly arranged and undoubtedly are morphologically the same. Their irregular arrangement suggests that the seeming regularity of some of the granules is due to the failure of others to be preserved. Meek and Worthen's descriptions of *G. scitulus* do not mention regularly arranged nodes and their possible presence on *G. scitulus* is based on descriptions by subsequent authors and on a row of nodes on the occipital segment of a fragmentary cephalon in the United States Geological Survey collection from the type locality of *G. scitulus*. Most of the differences cited are of degree rather than of kind but it seems better to place my specimens in a new species rather than to include them in one with whose description they do not agree, even though it seems likely that an examination of the type or of good specimens from the type locality may prove that description slightly misleading. If *G. scitulus* does have definite transverse glabellar furrows aside from those that delimit the basal lobes, as its description indicates, it does not conform fully to the description of *Griffithides*.

*G. olsoni* does not have the posterior part of its glabella divided into three knoblike nodes as does *G. parvulus;* it has no distinct indications of transverse glabellar furrows anterior to those that delimit the basal lobes as does this species; its facial sutures do not come nearly together in front; it does not, as before discussed, have single transverse rows of small but distinct nodes across the posterior part of the occipital segment and across each axial segment of the thorax and of the pygidium; and its length is less than twice its width. The length of *G. parvulus* is about two and one-half times its width.

From *G. ornatus*, *G. olsoni* differs because of its inconspicuous basal lobes, its smaller number of complete pleural segments on the pygidium, and its lack of distinct rows of rather large nodes on each axial segment of the thorax and pygidium. *G. ornatus* has basal lobes said to be prominent, seven complete pleural segments on the pygidium, and rather pronounced nodes arranged in a single row across each axial segment but grouped so as to form three double rows of nodes extending from the anterior of the thorax to the posterior of the axial lobe of the pygidium.

Walter[1] has suggested that the three species compared in the foregoing paragraphs with *G. olsoni* may belong to one species, *G. scitulus*. Of the types of these species, I have seen only that of *G. parvulus*, and can not test this suggestion adequately. It is undoubtedly true that changes in specific designations and perhaps in some of the kinds of characters used for specific distinctions will come when the trilobites of the Pennsylvanian are studied with the types and large collections assembled for careful scrutiny; and some species may then be found to be merely molts of other species. It is not desirable, however, to delay the description of newly collected material until such revisional studies are completed; and until new information based on typical material is available, it seems the most conservative course to recognize species as they are now generally recognized and use specific characters as they have been used.

Another species that is closely related to *G. olsoni* is *G. morrowensis* Mather 1915 from the Morrow group of Arkansas and Oklahoma. Mather's species is, however, a larger form. It has more pleural and probably more axial segments on its pygidium than does *G. olsoni*, and it also has a prominent median lobe between the two basal lobes of the glabella. Mather's figure suggests that it also has much narrower free cheeks.

*Significance of name:* This species is named for Mr. W. S. Olson, formerly of Columbia, Missouri, who collected one of the cotypes.

*Type material:* The cotypes are two in number. Both of them have the cephalon, thorax, and pygidium in articulation. Both also have part of the axis of the pygidium incomplete. The anterior part of the cephalon and part of the dorsal surface of the glabella has been removed by erosion from the smaller cotype. It is number 5183 of the type collections of Carboniferous invertebrate fossils of the United States Geological Survey; the larger cotype is number 5184 of the same collection.

*Description: Carapace* small, elliptical, slightly more than one and one-half times as long as wide; the cephalon, more than one-third as long as entire carapace, thorax shorter than cephalon, and pygidium about equal to or slightly shorter than thorax.

*Cephalon* semielliptical, evenly rounded in front on cotype 5184, incomplete in front of other cotype; surrounded by a longitudinally striated, narrow border or marginal rim which is distinctly above the free cheeks but is

[1] WALTER, OTTO T. Iowa Geol. Survey 31: 334. 1926(?)

not as high as the anterior part of the glabella; the border appears to be turned up in front of the glabella on cotype 5184 but neither cotype is complete enough to enable one to determine certainly that it is; the border extends beyond the genal angles and forms spines which reach to the fifth or sixth thoracic segment and are about one-half as long as the cephalon. The spines gradually become narrower from the genal angles until within about a half-millimeter of their ends where they rapidly narrow to a sharp point; on cotype 5183 the raised border extends across the posterior margin of the cephalon from the genal angles to the facial suture but it is narrower there than on the sides; on cotype 5184, the border on the posterior of the cephalon is visible but it is lower and less distinct. *Facial sutures* distinct posterior to the eyes on both cotypes and on cotype 5183 almost to the marginal rim or border, but their course across the border can not be traced because the border is broken or partly broken at every place that the facial sutures intersect it. The facial sutures cut the posterior margin of the cephalon at a point about midway between the longitudinal dorsal furrows and the genal angles; they extend obliquely forward from this point almost to the glabella but before reaching the glabella curve away from it around the palpebral lobes; from the anterior of the palpebral lobes they go at angles of about 20° with the longitudinal axis of the carapace toward the anterior lateral margins of the cephalon. *Free cheeks* depressed, as wide as the glabella at the mid-length of the eyes, almost flat except at border and around eyes. Eyes large, extending from slightly in front of the occipital furrow nearly half the distance to anterior margin of cephalon; semilunate; elevated as high above general level of free cheek as marginal rim, but not as high as glabella; granules distinctly visible only on cotype 5183. *Cranidium* with a large glabella and narrow fixed cheeks. Palpebral lobes opposite posterior two-fifths of glabella; separated from it by a distinct furrow. Glabella pyriform, prominent, occupying about one-third the width of the posterior of the cephalon and probably extending to the anterior margin; it widens about one-third its posterior width at the anterior margin and is much more highly elevated anteriorly; its front is nearly perpendicular. The glabella is not so prominent on cotype 5183 but it has apparently been worn off by erosion of this specimen. Basal lobes inconspicuous and indistinct; evidently worn down on cotype 5183; probably almost entirely preserved on cotype 5184; as preserved, the basal lobes are more nearly suboval than subtriangular but the furrows separating the basal lobes from the rest of the glabella are not visible and they may be so slightly curving that they enclose subtriangular areas, parts of which are below the suboval areas, but this can not be ascertained and it appears most probable that the suboval raised areas constitute the basal lobes. Each lobe occupies about one-fourth the width of the posterior of the glabella. No other transverse glabellar furrows, except the occipital furrow, or indications of furrows are visible on cotype 5184. On the other cotype, a slight linear depression passes across the glabella in front of the basal lobes and if it were interpreted as a transverse glabellar furrow it would separate a median posterior lobe on the glabella from the anterior of the glabella. The absence of a transverse furrow on this part of cotype 5184, which is fairly well preserved, and the depth of the furrow and the presence of other furrows caused by erosion on the glabella of cotype 5183 strongly suggest that this is not a true glabellar furrow but is simply an erosional feature. *Occipital segment* about as wide as the two adjoining thoracic segments; separated from the rest of glabella by deep, wide furrow; surface of segment slopes upward from occipital furrow to posterior one-fourth of oc-

cipital segment where there is a narrow crest; a very short steep downward slope back of the crest continues to the posterior margin; a distinct node is visible in the center of the occipital segment on one cotype and is indicated on the other. *Surface* of glabella appears from fragments of the test preserved on cotype 5184 to have been rather coarsely pustulose; the remainder of the cephalon is less coarsely pustulose and pustules are not visible on many parts of it.

*Thorax* over one and one-half times as wide as long; slightly wider at anterior margin than at posterior margin; distinctly trilobate. *Axis of thorax* broad and moderately but not highly arched; more than twice the width of that portion of the pleural lobe above the abrupt down bending or fulcrum and equal or nearly equal to the entire width of pleural lobe. *Pleura* abruptly bent downward at about one-third their length from the longitudinal dorsal furrow; proximal portion of pleura forming a right or slightly obtuse angle with distal portion at fulcrum; on many of the pleural segments the angle formed at the fulcrum is extended into a distinct node. Each pleural segment is subdivided by a fine striation which extends below the fulcrum from near the longitudinal dorsal furrow and divides the segment into an anterior part which is about one-third and a posterior part which is about two-thirds as wide as the entire segment. Thorax of nine segments; distal ends of pleural segments not observed. *Surface of thorax* finely granulated but, aside from the nodes at the fulcra of the pleural segments, no granules large enough to be called nodes are present. On two or three posterior segments of the axis only a few granules are preserved and these have a linear arrangement which might give the impression that there is a single transverse row of granules across the segments of the axis of the thorax. Examination of anterior segments that are well preserved shows that they have many granules which are irregularly arranged and this observation suggests that the seeming arrangement of the granules in single transverse rows across the posterior axial segments may be only a result of the failure of many other granules to be preserved. The irregular arrangement of most of the granules and their small size prevents their being interpreted as nodes similar to those which are regularly arranged on many species of *Griffithides*.

*Pygidium* subsemielliptical, nearly twice as wide as long, surrounded by a smooth, uniform, slightly convex border which varies in convexity on different parts of the pygidium but does not vary much in width. *Axis* partly broken on both cotypes; from parts of axis preserved one would judge that it was prominent and highly arched but probably had a flattened area on top about equal to half its width. Axis extending from anterior of pygidium to marginal rim, about one-sixth length of pygidium from posterior of pygidium; gradually tapering, nearly twice as wide at anterior end as at posterior. Two anterior segments of axial lobe preserved on cotype 5183 and three anterior segments preserved on cotype 5184. A few fine irregularly arranged granules ornament the segments of the axis but no nodes are visible. Each lateral or *pleural lobe* bent nearly at right angles to the general plane of the carapace at about one-third its width from longitudinal dorsal furrow at front of pygidium; at the posterior part of pygidium the bend is about one-half the width of pleural lobe from the longitudinal dorsal furrow. A row of nodes, one at the fulcrum of each segment, ornaments each pleural lobe. Six complete and one incomplete pleural segments can be distinguished on the pygidium of cotype 5184 and on one side of the pygidium of cotype 5183; the other side of the latter cotype is not completely preserved. Pleural segments distinct; separated by distinct intersegmental furrows; not subdivided as

those of the pleura of the thorax by transverse striae; terminating in the smooth border that surrounds the pygidium. With the exception of the nodes at the fulcra there are no recognizable nodes on the pleural segments but a few granules on the pleural segments suggest that they were granulose.

*Dimensions:* Measurements of the two cotypes, 5183 and 5184, are respectively as follows:

Length of carapace 13 mm. and 14.4 mm.; greatest width of carapace, measured at posterior of genal spines, 8.3 mm. and 9 mm.; length of cephalon, including occipital segment, 5 mm. and 5.6 mm.; length of thorax 3.6 mm. and 4.3 mm.; length of pygidium 3.6 mm. and 4.2 mm.; greatest width of cephalon, 0.6 mm. and 0.6 mm.; approximate width of genal spines at genal angle, 0.65 mm. and 0.65 mm.; width of glabella at posterior of cephalon 2.6 mm. and 2.7 mm.; width of glabella at anterior margin, 3.2 mm. and 3.6 mm.; probable greatest diameter of basal lobes (measurements uncertain), 0.6 mm. and 0.6 mm.; width of occipital segment 0.7 mm. and 0.8 mm.; greatest width of thorax 6.9 mm. and 7.8 mm.; width of axis of thorax at anterior of thorax, 2.6 mm. and 3 mm.; width of portion of pleural segment above fulcrum, 0.9 mm. and 1.1 mm.; approximate width of portion of pleural segments below fulcrum 1.4 mm. and 2.1 mm.; width of pygidium, 5.4 mm. and 6.8 mm.; length of pygidium 3.8 mm. and 4.3 mm.; approximate width of border around pygidium, 0.65 mm. and 0.72 mm.; width of axis of pygidium at anterior of pygidium, 2 mm. and 2 mm.; approximate width of posterior end of axis of pygidium 1.1 mm. and 1.2 mm.; approximate length of axis of pygidium, 3.2 mm. and 3.6 mm.

*Remarks:* This species has relatively larger eyes than is characteristic of the genus. Although it has small irregularly arranged granules, it is also without the transverse rows of coarse pustules or nodes seen on many species of the genus. Its glabella is, however, typical of forms commonly referred to *Griffithides*.

*Horizon and locality:* Cherokee shale, probably about bed 15 of Broadhead's section[3] and horizon of bed 15 of Hinds and Greene's section,[4] nine feet above Tebo coal horizon, second limestone (about 30 feet) stratigraphically above Pennsylvanian-Mississippian contact: Hinkson Creek, east side of creek, about four feet above ordinary water-level, about one-eighth mile north of bridge on road from Columbia, Missouri, to Edwards brick plant; west of and in creek below brick plant. The locality is about 1 mile east of Columbia, Missouri, and about in the NW. ¼, sec. 8, T. 48 N., R. 12 W. The beds dip to the southwest at this exposure and basal Pennsylvanian fire-clay is exposed 30 to 40 feet north of and more or less continuous with the exposure.

[3] BROADHEAD, G. C. Missouri Geol. Survey 12 (pt. 3): 385. 1898.
[4] HINDS, HENRY and GREENE, F. C. Missouri Bur. Geology and Mines 13 (2nd ser.): 57. 1915.

## PHYTOPATHOLOGY.—*The dark ages in Plant Pathology in America: 1830–1870.*[1] NEIL E. STEVENS, Bureau of Plant Industry. (Communicated by C. L. SHEAR.)

Many of the important activities in the history of plant pathology in the United States were initiated during the decade 1871 to 1880.

[1] Received February 16, 1933.

In 1871 there appeared in the Report of the Commissioner of Agriculture the first report on *The Fungoid Diseases of Plants* by Dr. Thomas Taylor, the recently appointed Microscopist of the Department. In 1873 Burrill first taught plant pathology incidentally with botany at the University of Illinois and in 1875 it was taught as a special subject by Farlow at Harvard. In 1875 also there was passed in Michigan the first law aimed at the eradication of peach trees affected by yellows and establishing the first quarantine against this disease. In 1879 Burrill transmitted the blight of pear by direct innoculation.

During this decade, there were established also the first State Experiment Stations. And soon after its close in 1882, Millardet in France began the experimental work with Bordeaux mixture, which was soon to have such an important bearing on American plant pathology. So important were the various lines of work initiated during this decade of 50 to 60 years ago that it is rather common to consider them the beginnings of plant pathology in this country as a recognized, organized study and the history of this branch of science since that time has been frequently reviewed. This, of course, makes all the more fascinating the assembling of information regarding the study of plant diseases and plant disease control prior to 1870. For the purposes of the present paper attention will be directed to the period 1830 to 1870.

## THE ECONOMIC BACKGROUND

The period was not one favorable for intensive efforts at disease control. With the exception of the war years it was a period of tremendous crop surpluses and at times of great economic depression in agriculture. In the agricultural literature of the time one finds statements which sound strangely like those we have been reading during the last few years. For example, in a letter from A. Jackson to Dr. Coleman dated April 26, 1834, we find:

> "I ask, what is the real situation of the agriculturist? Where has the American farmer a market for his surplus produce? Except for cotton, he has neither a foreign nor a home market. Does not this clearly prove, when there is no market at home or abroad, that there is too much labor employed in agriculture? Common sense at once points out the remedy. Take from agriculture 600,000 men, women and children, and you will at once give a market for more breadstuffs than all Europe now furnishes."

This letter is quoted by Henry L. Ellsworth then Commissioner of Patents in his report dated January, 1843, (2) and he comments as follows:

"The present, too, seems to be the proper time for us to give to this question of the disposal of our immense surplus a thorough, calm, and deliberate investigation. On the decision of it the prosperity of this great country depends. It has been well said that, 'to encourage the progress of agricultural improvement is the only road to national wealth.' Our object should not be so much to stimulate to large production, as to open the ways and means by which the husbandman shall have a market, and shall know how his labor and skill may be most available."

Arguments, of course, were presented in favor of more intensive investigations and the improvement of methods. For example, in the Report of the Corresponding Secretary of the New York Agricultural Society for 1842, we find the following sentence:

"Amidst the cares and perplexities of a period of unexampled pecuniary disaster and agricultural depression, it is not perhaps singular that a want of leisure and a want of spirit should unit to interrupt the execution of such a task; but surely there is no time when the husbandman is more imperiously called upon to make diligent efforts to cheapen and render more available every process of tillage—to add to the value of his products and animals—in a word, to adopt correct, safe, and economical systems, than when the prices he receives for his products are lowest."

## INTEREST IN AGRICULTURAL CHEMISTRY

Agricultural education seems to have largely centered on the study of chemistry and soils. A careful review of 14 American textbooks of agriculture published during this period (8) indicates a predominance of interest in problems of the composition of plants, composition of soils and in fertilizers. In only three or four of these texts do we find mention of plant diseases, and only one, *The American Text Book of Practical and Scientific Agriculture*, by Charles Fox, contains more than casual references to disease.

The faith of the farmers of the time in the ability of chemists to settle their problems is rather touching. We note, for instance, at a meeting of the Maryland Farmers' Club on December 13, 1845, that the Club wanted some information regarding a "troublesome disease of potatoes." It was, of course, the then newly discovered and exceedingly destructive late blight. They accordingly called upon Professor Baer, who was the "lecturing and practical agricultural chemist," and asked him to get a pound each of healthy and diseased potatoes and analyze them. His report in April, 1846, records his analyses and his conclusion that the disease was "a putrefactive fermentation produced by the condition of the atmosphere and improper cultivation."

## DISEASE SURVEY WORK

The modest additions to our information regarding plant diseases made during this perod were not in their control but rather in records of their prevalence or what we would now call survey work. This was probably a direct reflection of the interest in geological surveys during the period or at least an outgrowth of the same attitude of mind which produced and developed the geological surveys. In Merrill's masterly sketch of American State Geological and Natural History Surveys (5), we note that no less than 29 States inaugurated such surveys during the period 1833 to 1865, following the example of North Carolina which had already organized a natural history survey in 1824. By comparison with the geological surveys the assembling of plant disease information was crude in the extreme. It may, however, be said in defense of these early workers that plant disease survey work is still undeveloped in comparison with the type of survey work carried on by geologists, and that those interested in plant disease information nearly a century ago fully realized the limitations of the conditions under which they were working.

We find that in 1842 the Commissioner of Patents, who was in charge of the agricultural work of the United States government, asked for funds which would enable him to make by observation in the field, a personal study of crops and agricultural implements. He also stated that during the previous year (1841) he had traveled in 10 states, where he had studied the crops, and was in this way better able to pass judgment on the statistics submitted to the Office.

Early in the period under review Massachusetts made an appropriation for an agricultural survey of the State and in the outline for this work published by Henry Colman in 1837, Commissioner for the Survey, plant diseases are specifically mentioned. It is perhaps natural that under conditions of economic stress, particularly those due to over-production, the tendency is toward surveys to see just where industry stands.

## DISEASE CONTROL METHODS

The methods of disease control in use in this country from 1830 to 1870 were largely copied directly from European practices or carried over from previous experience. At least, I have thus far failed to find any distinctly new type of disease control developed during this period.

### *Barberry Eradication*

Barberry eradication, which excited so much interest in Colonial Massachusetts and Connecticut between 1726 and 1764, had been

abandoned as a means of controlling wheat rust due apparently in part to a too great dependence on the mycology of the day. Thus we find in an 1843 prize essay of the New York State Agricultural Society by John J. Thomas on *The Diseases and Insects Injurious to the Wheat Crop* the following statement:

"The barberry.—This is not unfrequently supposed to be a cause of blight, and a slight similarity in external appearance between the barberry blight or rust and wheat rust, has contributed to the notion. But, on examination, these two kinds of blight are found to be caused by fungi totally different in appearance under a magnifier: they belong even to different genera, the one being the *Æcidium berberides*, and the other the *Puccinia graminis*, and the transmutation of one to the other would be equal to the absurdity of the conversion of wheat to chess."

It may be remembered, however, that barberry eradication as practiced in New England did not go unchallenged even during the eighteenth century, for in his notes on *Travels in the Confederation* (1783–1784), Johann David Schoepf (6) made the following observation:[2]

"In New England the common barberry is in evil repute. There is laid to its charge that its proximity is injurious to the growth of wheat and other field crops. Whether it is a positive or a negative injury, that is, whether it works damage actively, corrupting the atmosphere, or merely exhausts the better juices of the soil, nobody has been able or willing to determine. However, a strict law has been passed against the poor barberry, making the inhabitants responsible, with no further judicial process, for the carrying out of the death sentence imposed upon both varieties of this shrub, (elsewhere harmless) whenever it makes its appearance—if any man extends protection to the shrub his neighbor has the right to enter and destroy, and can bring action against the slothful or unbelieving condoner for damage and trouble incurred. But the New Englanders are known for other strange beliefs and practices as well, and it was among them that witch trials, at the beginning of the century, were so grimly prosecuted."

### *Seed Treatment*

That the methods of seed treatment known in England were brought to this country and used by the more progressive farmers is evidenced by various references to it as a common practice. For example, in the report of the Commissioner of Patents for 1844 (2, p. 374) there is a detailed report of seed treatment for wheat smut:

"The substances used are, sulphate of copper, or blue vitriol, wine, common salt, wood ashes, lime water and sometimes arsenic. The smut which is sometimes found in wheat is called dust brand, or pepper brand. It is sometimes called *Uredo foetida*.

"A gentleman near Baltimore has for several years been in the habit of

[2] Quoted from the translation of Alfred J. Morrison (6)–1911.

washing his seed wheat in a strong solution of glauber salts, (sulphate of soda,) with the view of preventing smut with success. He says he makes the solution strong enough to bear an egg, fills a tub half full of it, and then pours in half a bushel of wheat at a time, stirs it round well with the hand, skims off all the floating grains and other foul matters, dips out the wheat with a colander, lets it drain, spreads it out on the barn floor till not quite dry, then rolls it in air slaked lime, and sows it.

"Dissolve a pound of blue stone in as much water as will cover five bushels of wheat, and let it remain about 18 hours before it is sown, and you will never have smut in your wheat."

"Sow your wheat the first of October, and when you harvest let what you intend to make seed of remain five or six days longer in the field before it is cut."

The use of these treatments was, of course, by no means universal, and we find in the report of the Commissioner of Patents in 1851 a report from Maryland and Virginia that most farmers sowed their wheat without any preparation. One farmer states, however, "I find that soaking my wheat in strong brine answers a valuable purpose and I never have smut with wheat so treated."

### *Soil and Cultural Treatments*

The interest in the great epidemic of potato late blight was so intense that there were undoubtedly tried or at least suggested all the known disease control methods. The summary of the suggested methods is given in the Report of the Commissioner of Patents for 1844.

"The remedies suggested are: To keep such as are intended for seed deep buried in the ground all winter; thoroughly draining and subsoiling the land where planted; to put them in small quantities; to select seed for planting, not quite ripe, and such as have not the slightest appearance of being watery; liming the land; obtaining new seed, either from planting potato balls or from distant countries, where they grow in a healthy state; after digging, spread the potatoes in the sun till they become dry and unfit for food; then stow them away till required for planting—topdressing the plant with nitrate of soda and sulphate of soda and magnesia; selecting such tubers for seed as were grown near the top of the ground, and are quite green; to plant the seed whole. Salt, lime, and plaster, have been respectively recommended by their advocates, and, in some instances, with diverse success.

"An instance is related where, on planting, a tablespoonful of lime was placed in each hill; and, after they were up, was applied about a gill of a mixture—of lime 2 bushels, plaster 3, and ashes 8. In this case there was not one rotten potato in the fall, while in the fields of his neighbors they were much diseased."

### AN EARLY ANALYSIS OF PEACH AFFECTED WITH YELLOWS

The great interest in and devotion to chemistry during the period is evident in relation to plant diseases. Thus we find in 1849 that

Emmons (3) published in a paper on *Analysis of Fruit Trees*, an analysis of leaves of a healthy peach tree and one affected with yellows. This analysis was quoted and commented on in at least one textbook of the period, and represents another early attempt in this country to gain information about a disease by analyzing the affected host parts.

### THE SPREAD OF POTATO LATE BLIGHT 1843–1845

The most notable disease outbreak of the period, indeed one of the most notable in our national history, was that of late blight of potatoes (caused by *Phytophthora infestans* [Mont.] DeBy). Reference to attempts at control has already been made, and in justice to a little known student of American botany it should be said that as early as 1845 J. E. Teschemacher, Curator in Botany of the Boston Natural History Society, had studied the disease and become convinced that it was caused by a fungus. He wrote his opinion to Commissioner Colman, and the letter was published in the Gardeners' Chronicle (7) and is cited by Berkeley (1).

Of chief interest to us, however, is the record of the spread of the disease in the United States found in the records of the Commissioner of Patents. In view of the importance of the disease and the crop, and particularly of the world wide interest in the disease as a major cause of the Irish famine of 1845 and 1846, it is surprising that no maps of its spread have been prepared and published. I fail to find any, however, in available literature. The reports are remarkably full and accurate for the critical years. Definite parts of States are often indicated and in at least one year latitudes are specifically mentioned. There can be no question that the disease dealt with is late blight. For example, the report for New York for 1843 (2), says: "Potatoes are subject to dry rot, attacking some in the hill, and some in the heap, and fatal to the whole wherever it makes its appearance, causing them to rot and to emit a very offensive stench."

No records of the disease being observed in 1842 could be found either in the transactions of any of the Horticultural Societies or in the Report of the Commissioner of Patents. On the contrary, in all the New England States as well as New York, New Jersey, Pennsylvania, Maryland, and Virginia west of the mountains (that is West Virginia) there are reports of an average or better than average yield of potatoes and where quality is indicated it was above average. The rot is everywhere referred to in 1843 and 1844 as a "New Disease."

The only reference in available literature to the disease as occurring

in this country in 1842 is based on a letter written in 1887, 45 years after the event. The impression that late blight was observed in the United States in 1842 is apparently drawn from Farlow's paper *The Potato Rot* (4). But Farlow had but recently returned from study in Europe and was obviously referring to world conditions when in 1875 he wrote, "The disease occurred in this violent form in 1842, and again in 1845."

The progress of the disease is best shown by the maps. There are

Fig. 1. The known distribution of potato late blight in 1843.

definite records of the disease in 1843 in the five States nearest Philadelphia and New York City, (Fig. 1), with Pennsylvania and Delaware estimating losses of 50 per cent, and New York reporting some counties with 50 per cent and others from 12 to 15 per cent. The New Jersey report for the next year indicates that the loss due to this disease in 1843 exceeded 15 per cent. The presence of the disease in Connecticut is indicated but no estimate of loss is given. The Maine crop appears to have had "its usual good quality."

In 1844 there was evidently great interest in the disease. The records are full and definite. They are summarized as follows in the Report of the Commissioner of Patents:

"So far as we have been able to trace its boundary, it has not in any instances in this country extended beyond 45° northern latitude nor farther south than the 37°, if indeed it has gone so far. We have not observed any notice of it higher up than Piscataquis County, Maine. It does not seem to have gone lower than a line drawn diagonally through Trumbul County in Ohio, and so passing through part of Pennsylvania and on down to the District of Columbia. There seems to be none of it in Canada." (Fig. 2.)

The disease had thus apparently not reached the important potato producing area of Maine. Even in the southeastern section of that

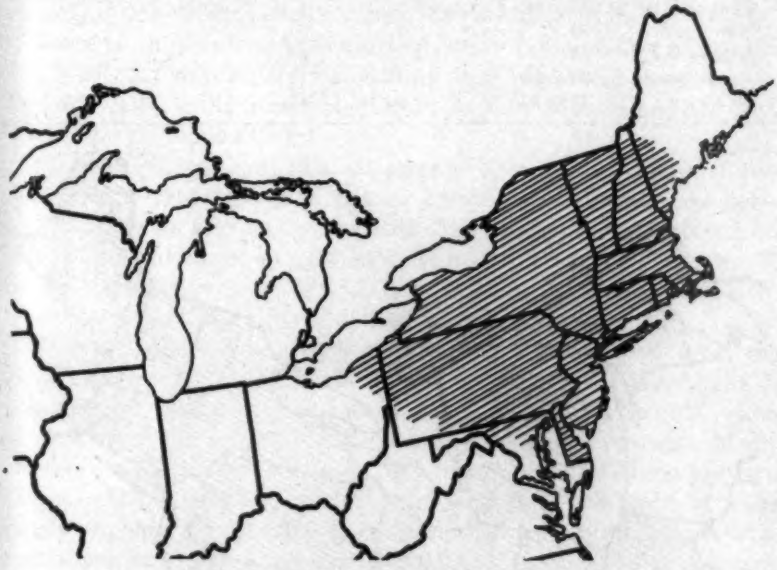


Fig. 2. The known distribution of potato late blight in 1844.

State it was reported that there was "A good crop, very few rotted, and the quality good."

In the other New England States, however, as well as in New York, Pennsylvania, New Jersey, and Delaware, severe losses were noted, although they were apparently less in New Jersey and Pennsylvania than during the previous year (1843). In Maryland and West Virginia the crops were below normal but this is definitely stated to be due chiefly to drought. In Ohio there was also a falling off in the crop due to drought, and in the northeastern part of the State most of the crop was reported to have rotted after harvest. (See Table I.) The report that the potato crops in Maryland, West Virginia, and southern

TABLE 1

ESTIMATES OF THE POTATO CROP OF VARIOUS STATES IN 1844, IN COMPARISON WITH PREVIOUS YEARS, AS AFFECTED BY THE FACTORS INDICATED:

| Percentage losses due to late blight | | Percentage shortage due to drought | | Percentage increase in yield over previous years | |
|---|---|---|---|---|---|
| New Hampshire | 25 | Maryland | 25 to 30 | Maine | +15 |
| Vermont | 25 | West Virginia | 20 | Michigan | +20 |
| Massachusetts | 25 to 30 | Ohio | 25 | Indiana | +25 |
| Rhode Island | 10 | | | Wisconsin, Iowa | a considerable increase |
| Connecticut | 25 to 30 | | | | |
| New York | 50 | | | | |
| New Jersey | 15 | | | | |
| Pennsylvania | 20 to 25 | | | | |
| Delaware | 25 to 30 | | | | |

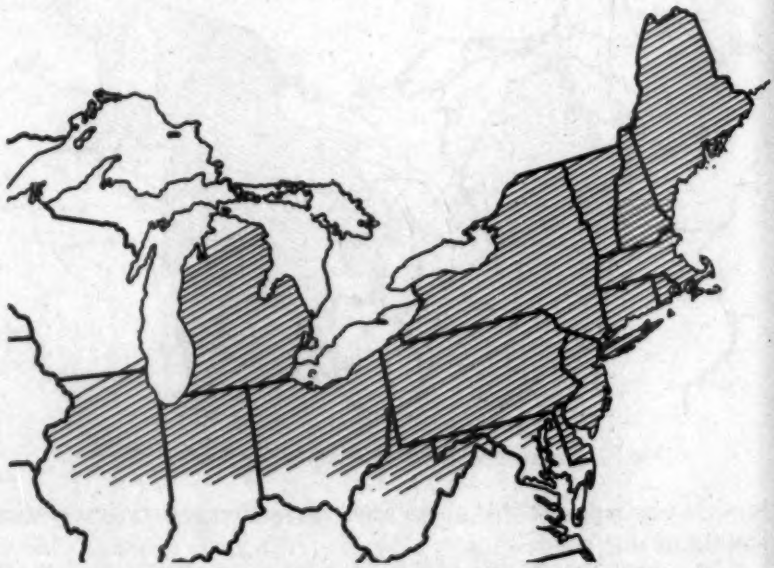


Fig. 3. The known distribution of potato late blight in 1845.

Ohio were short due to the drought is substantiated by such weather records as are available. For instance, in Washington, D. C., and Baltimore, Maryland, the total rainfall for the year 1844 was 32.46 inches as compared with a normal of 41 inches, and the rainfall for June, July, and August, was 1.70, 3.90, and 0.31, respectively, while the normals are about 4.10, 4.49, and 4.22. A somewhat similar although smaller difference appears in the records for Marietta, Ohio.

Reports indicate that in 1844 the group of States around Lake Michigan produced a potato crop well above the average. Michigan reports 20 per cent increase over the previous year, Indiana, 25 per cent increase, and Wisconsin better than average.

In 1845, the Patent Office Report states that the disease was noted farther East, West, North, and South than the previous year, and specifically mentions its appearance in Illinois, Indiana, and Michigan. It also spread to Canada and Nova Scotia, and was "very severe" in Maine. Its distribution in 1845 is indicated in Fig. 3.

There is no report on agriculture by the Commissioner of Patents for 1846, but apparently losses from late blight continued severe through 1847 being mentioned from Maine, Massachusetts, New York, Maryland, and Ohio.

By 1848, the disease had apparently become recognized as one of the important factors in potato growing, and losses were being compared with previous years, although the hope was still entertained that the disease might soon spend its strength. There are, of course, numerous reports in 1850 and 1851 but these become so scattered and generalized as to be of little value.

He would indeed be a rash historian who would insist that the great epidemic of 1843–45 was the first occurrence of late blight of potatoes in North America, since the beginning of potato cultivation or even since the arrival of Europeans. The first appearance of the disease near the great ports, and its rapid spread in three growing seasons, during which it reached something near the limits of what finally proved to be its area of greatest importance both suggest a recent introduction. As the disease was well established in Ireland, England, and on the continent of Europe in 1842 its prompt introduction on the Atlantic Seaboard of North America can be easily understood. That one can now prepare maps of the annual spread of the disease, exceeded in accuracy in our own day only by the maps of the spread of the chestnut bark disease, is no small tribute to the plant disease reports of ninety years ago.

## LITERATURE CITED

1. Berkeley, M. J. *Observations botanical and physiological on the potato murrain.* Journ. Hort. Soc. London. 1: 9.—1846.

2. Ellsworth, H. L. Report of the Commissioner of Patents for 1842, 1843, 1844, 1845, 1847, 1848.

3. Emmons, Ebenezer. *Analysis of fruit trees.* U. S. Patent Office Report (Agriculture). 1849: 475–484.

4. Farlow, W. G. *The potato rot.* Bull. Bussey Inst. 1: 319–338. 1875.

5. Merrill, G. P. *Contributions to a history of American State geological and natural history surveys.* Smithsonian Inst. U. S. Nat. Museum Bul. 109. 1920.

6. SCHOEPF, JOHANN DAVID. *Reise durch einige der mittleren und südlichen vereinigten nordamerikanischen Staaten nach Ost-Florida und den Bahama-Inseln, unternommen in den Jahren 1783 und 1784.* Erlangen, J. J. Palm, 1788. 2 vol.
————. *Travels in the confederation (1783–1784).* Translated and ed. by Alfred J. Morrison. Philadelphia, W. J. Campbell, 1911. 2 vol.
7. TESCHEMACHER, J. E. *Observations on the Potato Disease.* Gardeners Chronicle 1845: 125.
8. TRUE, A. C. *History of agricultural education in the United States. 1785–1925.* U. S. Dept. Agric. Misc. Pub. 36: 436. 1929.

## SCIENTIFIC NOTES AND NEWS

*Prepared by Science Service*

### NOTES

*Science advisory board.*—One of the most important steps that has yet been taken by the new Administration is the appointment, by executive order dated July 21, of a Science Advisory Board to cooperate with the Federal Government in the handling of all problems in which science is involved.

The President's executive order establishing the new board is as follows:

"The National Research Council was created at the request of President WILSON in 1916 and perpetuated by Executive Order No. 2859, signed by President WILSON on May 11, 1918. In order to carry out to the fullest extent the intent of the above Executive Order there is hereby created a Science Advisory Board with authority, acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council, to appoint committees to deal with specific problems in the various departments.

"The Science Advisory Board of the National Research Council will consist of the following members who are hereby appointed for a period of two years: KARL T. COMPTON, Chairman, President, Massachusetts Institute of Technology, Cambridge, Massachusetts; W. W. CAMPBELL, President, National Academy of Sciences, Washington, D. C.; ISAIAH BOWMAN, Chairman, National Research Council, and Director, American Geographical Society, New York City; GANO DUNN, President, J. G. WHITE Engineering Corporation, New York City; FRANK B. JEWETT, Vice-President, American Telephone and Telegraph Company, and President, Bell Telephone Laboratories, Incorporated, New York City; CHARLES F. KETTERING, Vice-President, General Motors Corporation, and President, General Motors Research Corporation, Detroit, Michigan; C. K. LEITH, Professor of Geology, University of Wisconsin, Madison; JOHN C. MERRIAM, President, Carnegie Institution of Washington, Washington, D. C.; R. A. MILLIKAN, Director, Norman Bridge Laboratory of Physics, and Chairman of the Executive Council, California Institute of Technology, Pasadena, California."

*Great white spot on Saturn.*—A white spot, so large that it could engulf an object over twice the diameter of the earth, has appeared suddenly on the equator of Saturn, the ringed planet and second largest of the solar system.

It was discovered by JOHN E. WILLIS, U. S. Naval Observatory astronomer at 12:18 A.M. Saturday, August 5, while he was observing Saturn through the six-inch transit instrument. Although he observed the planet for only about a minute before it left the field of view, Mr. WILLIS recognized the spot and called upon other astronomers at the observatory to check his discovery. Principal Astronomer H. E. BURTON turned the 26-inch

and the 12-inch telescopes upon the planet and confirmed the discovery. Capt. J. F. HELLWEG, superintendent of the Naval Observatory, reported the discovery to Harvard College Observatory, when it was bulletined to observatories throughout the world.

The spot was also noticed by a London music hall comedian and amateur astronomer, WILL HAY, nearly 27 hours before it was found independently at the Naval Observatory. Mr. HAY was looking at the planet Thursday night, August 3, through a six-inch refracting telescope at Norbury when he saw the spot and notified Dr. W. H. STEAVENSON who confirmed the discovery. The British Astronomical Association issued a bulletin on the discovery which was circulated among British astronomers.

On Saturday morning it was estimated that the spot was about a tenth the diameter of the planet, but on Saturday night Principal Astronomer BURTON with the 26-inch telescope found that the spot was much larger. While difficult to measure because not well defined, the spot seemed to be about 20,000 miles long and 12,000 miles wide, being formed by a sort of extension in the brighter equatorial belt of the planet. It is expected that the spot will continue to be observable for several weeks.

Only twice before do astronomical records show that such spots have been observed on Saturn. The first was seen through the same 26-inch Naval Observatory lens in 1876 by the Late Prof. ASAPH HALL, Sr., just three years after the telescope was built. By using the spot as a mark of reference Prof. HALL was able to make the determination of the period of rotation of Saturn that is now quoted in astronomical tables, 10 hours, 14 minutes, 24 seconds. The 1876 Hall spot was not so large as the Willis spot now visible. Mr. WILLIS used the Hall determination of Saturn's period of rotation in predicting when the spot would return to visibility, and Saturday night's observations showed that the Willis spot is revolving around on the planet in about the expected time. The second spot on Saturn was discovered by the late Prof. E. E. BARNARD of Yerkes Observatory in 1903. Unlike the Hall and Willis spots, the Barnard spot was considerably north of the planet's equator.

*International Geological Congress.*—The International Geological Congress held its sixteenth session in Washington, from July 22 to 29. The last preceding session had been held in South Africa in 1929. The Washington meeting was distinguished by the considerable number of foreign delegates and guests, in addition to a full attendance by American geologists.

Papers at the session grouped themselves around the following general topics: measurement of geologic time, batholiths and related intrusives, zonal relations of metalliferous deposits, major divisions of the paleozoic era, geomorphogenic processes in arid regions, fossil man and contemporary faunas, orogenesis, geology of petroleum, geology of copper deposits, miscellaneous ore deposits.

One of the outstanding papers was that of Sir ARTHUR SMITH WOODWARD, who reviewed and brought down to date all the data concerning ancient man in the Old World, with special reference to *Sinanthropus* and his relations to *Eoanthropus* and modern man. At the same session the present status of the still-vext question of man's antiquity on the American continent was discussed by Dr. J. C. MERRIAM, Dr. CHESTER STOCK and BARNUM BROWN.

The meeting in Washington was preceded by several field excursions into various regions of geological interest in the eastern, southeastern and central states, together with a transcontinental excursion starting from San

Francisco, for the benefit of western and trans-Pacific geologists. At the close of the sessions two additional excursions, both transcontinental, took the field.

*Agreement on mineralogical nomenclature.*—A joint session of the British and American committees on mineralogical nomenclature was held during the Sixteenth International Geological Congress, in Washington, D. C., July 25, 1933, and was specially notable in the almost complete accord reached in the subjects under discussion. The aim of the joint meeting was to strive for uniformity in the names used for mineral species, in spelling and pronunciation, and in the symbols used in mineralogical and crystallographical descriptions. On a very few items only was it deemed advisable to refer the questions to a subcommittee for further debate.

The British Committee, representing the Mineralogical Society of Great Britain and Ireland, consisted of Sir JOHN FLETT, Director of the Geological Survey of Great Britain, Chairman; Dr. W. CAMPBELL SMITH of the Mineral Department, British Museum; and Prof. CHARLES G. CULLIS, Professor of Economic Mineralogy, Imperial College of Science and Technology, London.

The members of the American Committee, representing the Mineralogical Society of America, who were present consisted of Dr. WALDEMAR T. SCHALLER, U. S. Geological Survey, Washington, D. C., Chairman; Prof. ESPER S. LARSEN, Harvard University; Dr. CLARENCE S. ROSS, U. S. Geological Survey (who proxied for Dr. WILLIAM T. FOSHAG, U. S. National Museum); Dr. J. FRANK SCHAIRER, Carnegie Geophysical Laboratory; Prof. T. L. WALKER, University of Toronto; and Prof. E. T. WHERRY, University of Pennsylvania. Prof. A. N. WINCHELL, University of Wisconsin, was unable to attend.

*Abstracting service.*—On June 22, 1933, a conference was held at the University of Chicago with Professor J. R. SCHRAMM, editor of *Biological Abstracts*, and with associate editors, Drs. W. C. ALLEE, GEORGE D. FULLER, CHANCEY JUDAY, and several others for the purpose of perfecting plans to provide fishery research workers in America with an adequate abstracting of scientific literature bearing upon their field of work. The Bureau of Fisheries was represented by ELMER HIGGINS, Chief of the Division of Scientific Inquiry, who has been active in promoting the project.

It was tentatively decided to establish a separate heading for abstracts of papers dealing with Fisheries Biology and Aquiculture, giving them independent rank comparable in importance to such branches of science as animal husbandry and economic entomology.